

WHAT IS CLAIMED IS:

1. A piezoelectric ceramic composition of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z-w}Ta_zSb_w)O_3$, where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$.
2. A piezoelectric ceramic composition as set forth in claim 1, wherein the range of said x in said general formula is $0 < x \leq 0.2$.
3. A piezoelectric ceramic composition as set forth in claim 1, wherein the value of said x in said general formula is $x=0$.
4. A piezoelectric ceramic composition as set forth in claim 1, wherein the range of said y in said general formula is $0 < y \leq 1$.
5. A piezoelectric ceramic composition as set forth in claim 1, wherein the value of said y in said general formula is $y=0$.
6. A piezoelectric ceramic composition as set forth in claim 1, wherein said piezoelectric ceramic composition has a piezoelectric d_{31} constant of not less than 30 pm/V.
7. A piezoelectric ceramic composition as set forth in claim 1, wherein said piezoelectric ceramic composition has a piezoelectric g_{31} constant of not less than 7×10^{-3} Vm/N.
8. A piezoelectric ceramic composition as set forth in claim 1, wherein said piezoelectric ceramic composition has an electromechanical coupling coefficient K_p of not less than 0.3.
9. A piezoelectric ceramic composition as set forth in claim 1, wherein said piezoelectric ceramic composition has a dielectric loss of not more than 0.09.
10. A piezoelectric ceramic composition as set forth in claim 1, wherein said piezoelectric ceramic composition has a relative dielectric constant of not less than 400.

11. A piezoelectric ceramic composition as set forth in claim 1, wherein said piezoelectric ceramic composition has a Curie temperature T_c of not less than 200°C.

12. A piezoelectric ceramic composition as set forth in claim 1, wherein said piezoelectric ceramic composition has a piezoelectric d_{31} constant of not less than 30 pm/V and a Curie temperature T_c of not less than 200°C.

13. A piezoelectric ceramic composition as set forth in claim 1, wherein said piezoelectric ceramic composition has a piezoelectric g_{31} constant of not less than 7×10^{-3} Vm/N and a Curie temperature T_c of not less than 200°C.

14. A piezoelectric ceramic composition as set forth in claim 1, wherein said piezoelectric ceramic composition has an electromechanical coupling coefficient K_p of not less than 0.3 and a Curie temperature T_c of not less than 200°C.

15. A piezoelectric ceramic composition as set forth in claim 1, wherein said piezoelectric ceramic composition has a dielectric loss of not more than 0.09 and a Curie temperature T_c of not less than 200°C.

16. A piezoelectric ceramic composition as set forth in claim 1, wherein said piezoelectric ceramic composition has a piezoelectric d_{31} constant of not less than 30 pm/V, an electromechanical coupling coefficient K_p of not less than 0.3, and a Curie temperature T_c of not less than 200°C.

17. A method of production of a piezoelectric ceramic composition comprising shaping and sintering a powder comprised of a piezoelectric ceramic composition of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z}Ta_wSb_w)O_3$, where x , y , z , and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$.

18. A method of production of a piezoelectric

ceramic composition comprising mixing and sintering a compound containing lithium, a compound containing sodium, a compound containing potassium, a compound containing niobium, a compound containing tantalum, and a compound containing antimony so as to obtain a piezoelectric ceramic composition as set forth in claim 1.

19. A method of production of a piezoelectric ceramic composition as set forth in claim 18, wherein said compound containing lithium is Li_2CO_3 , said compound containing sodium is Na_2CO_3 , said compound containing potassium is K_2CO_3 , said compound containing niobium is Nb_2O_5 , said compound containing tantalum is Ta_2O_5 , and said compound containing antimony is Sb_2O_3 or Sb_2O_5 .

20. A piezoelectric element having a piezoelectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 1.

21. A dielectric element having a dielectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 1.

22. A piezoelectric ceramic composition having a compound of a general formula $\{\text{Li}_x(\text{K}_{1-y}\text{Na}_y)_{1-x}\}(\text{Nb}_{1-z}\text{Ta}_z\text{Sb}_w)\text{O}_3$, where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ as a main ingredient, wherein

said piezoelectric ceramic composition contains at least one metal element selected from palladium, silver, gold, ruthenium, rhodium, rhenium, osmium, iridium, and platinum as an added element, and a total of the contents of said added elements is 0.001 mol to 0.15 mol with respect to 1 mole of the compound of the above general formula.

23. A piezoelectric ceramic composition as set forth in claim 22, wherein a piezoelectric d_{31} constant of said piezoelectric ceramic composition is larger than a piezoelectric d_{31} constant of a piezoelectric ceramic composition of the above general formula not containing

said added elements.

24. A piezoelectric ceramic composition as set forth in claim 22, wherein an electromechanical coupling coefficient K_p of said piezoelectric ceramic composition is larger than an electromechanical coupling coefficient K_p of a piezoelectric ceramic composition of the above general formula not containing said added elements.

25. A piezoelectric ceramic composition as set forth in claim 22, wherein a piezoelectric g_{31} constant of said piezoelectric ceramic composition is larger than a piezoelectric g_{31} constant of a piezoelectric ceramic composition of the above general formula not containing said added elements.

26. A piezoelectric ceramic composition as set forth in claim 22, wherein a relative dielectric constant of said piezoelectric ceramic composition is larger than a relative dielectric constant of a piezoelectric ceramic composition of the above general formula not containing said added elements.

27. A piezoelectric ceramic composition as set forth in claim 22, wherein a dielectric loss of said piezoelectric ceramic composition is smaller than a dielectric loss of a piezoelectric ceramic composition of the above general formula not containing said added elements.

28. A piezoelectric ceramic composition as set forth in claim 22, wherein a Curie temperature T_c of said piezoelectric ceramic composition is larger than a Curie temperature of a piezoelectric ceramic composition of the above general formula not containing said added elements.

29. A piezoelectric ceramic composition as set forth in claim 22, wherein said piezoelectric ceramic composition has a piezoelectric d_{31} constant of not less than 30 pm/V.

30. A piezoelectric ceramic composition as set forth in claim 22, wherein said piezoelectric ceramic composition has an electromechanical coupling coefficient

Kp of not less than 0.3.

31. A piezoelectric ceramic composition as set forth in claim 22, wherein said piezoelectric ceramic composition has a piezoelectric g_{31} constant of not less than 7×10^{-3} Vm/N.

32. A piezoelectric ceramic composition as set forth in claim 22, wherein said piezoelectric ceramic composition has a relative dielectric constant of not less than 400.

33. A piezoelectric ceramic composition as set forth in claim 22, wherein said piezoelectric ceramic composition has a dielectric loss of not more than 0.09.

34. A piezoelectric ceramic composition as set forth in claim 22, wherein said piezoelectric ceramic composition has a Curie temperature T_c of not less than 200°C.

35. A piezoelectric ceramic composition as set forth in claim 22, wherein said piezoelectric ceramic composition has a piezoelectric d_{31} constant of not less than 30 pm/V and a Curie temperature T_c of not less than 200°C.

36. A piezoelectric ceramic composition as set forth in claim 22, wherein said piezoelectric ceramic composition has a piezoelectric g_{31} constant of not less than 7×10^{-3} Vm/N and a Curie temperature T_c of not less than 200°C.

37. A piezoelectric ceramic composition as set forth in claim 22, wherein said piezoelectric ceramic composition has an electromechanical coupling coefficient Kp of not less than 0.3 and a Curie temperature T_c of not less than 200°C.

38. A piezoelectric ceramic composition as set forth in claim 22, wherein said piezoelectric ceramic composition has a dielectric loss of not more than 0.09 and a Curie temperature T_c of not less than 200°C.

39. A piezoelectric ceramic composition as set forth in claim 22, wherein said piezoelectric ceramic

composition has a piezoelectric d_{31} constant of not less than 30 pm/V, an electromechanical coupling coefficient K_p of not less than 0.3, and a Curie temperature T_c of not less than 200°C.

40. A method of production of a piezoelectric ceramic composition comprising mixing and sintering a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z}Ta_zSb_w)O_3$ where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ and an additive including at least one metal element selected from palladium, silver, gold, ruthenium, rhodium, rhenium, osmium, iridium, and platinum.

41. A method of production of a piezoelectric ceramic composition comprising mixing a compound containing lithium, a compound containing sodium, a compound containing potassium, a compound containing niobium, a compound containing tantalum, and a compound containing antimony by a stoichiometric ratio giving, after sintering, a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z}Ta_zSb_w)O_3$ where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ or a stoichiometric ratio considering substitution by a metal element contained in the following additive, mixing an additive containing at least one metal element selected from palladium, silver, gold, ruthenium, rhodium, rhenium, osmium, iridium, and platinum, and sintering the result.

42. A method of production of a piezoelectric ceramic composition as set forth in claim 41, wherein said compound containing lithium is Li_2CO_3 , said compound containing sodium is Na_2CO_3 , said compound containing potassium is K_2CO_3 , said compound containing niobium is Nb_2O_5 , said compound containing tantalum is Ta_2O_5 , and said compound containing antimony is Sb_2O_5 or Sb_2O_3 and said additive is at least one additive selected from PdO_2 , Ag_2O , Au , Au_2O , Ru_2O , RhO , Re_2O_5 , OsO_2 , IrO_2 , and

PtO₂.

43. A piezoelectric element having a piezoelectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 22.

44. A piezoelectric element having a piezoelectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 40.

45. A dielectric element having a dielectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 22.

46. A dielectric element having a dielectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 40.

47. A piezoelectric ceramic composition having a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z}Ta_zSb_w)O_3$, where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ as a main ingredient, wherein

said piezoelectric ceramic composition contains at least one metal element selected from nickel, iron, manganese, copper, and zinc as an added element, and

a total of the contents of said added elements is 0.001 mol to 0.08 mol with respect to 1 mole of the compound of the above general formula.

48. A piezoelectric ceramic composition as set forth in claim 47, wherein a piezoelectric d₃₁ constant of said piezoelectric ceramic composition is larger than a piezoelectric d₃₁ constant of a piezoelectric ceramic composition of the above general formula not containing said added elements.

49. A piezoelectric ceramic composition as set forth in claim 47, wherein an electromechanical coupling coefficient K_p of said piezoelectric ceramic composition is larger than an electromechanical coupling coefficient K_p of a piezoelectric ceramic composition of the above general formula not containing said added elements.

50. A piezoelectric ceramic composition as set forth in claim 47, wherein a piezoelectric g_{31} constant of said piezoelectric ceramic composition is larger than a piezoelectric g_{31} constant of a piezoelectric ceramic composition of the above general formula not containing said added elements.

51. A piezoelectric ceramic composition as set forth in claim 47, wherein a mechanical quality factor Q_m of said piezoelectric ceramic composition is larger than a mechanical quality factor Q_m of a piezoelectric ceramic composition of the above general formula not containing said added elements.

52. A piezoelectric ceramic composition as set forth in claim 47, wherein a relative dielectric constant of said piezoelectric ceramic composition is larger than a relative dielectric constant of a piezoelectric ceramic composition of the above general formula not containing said added elements.

53. A piezoelectric ceramic composition as set forth in claim 47, wherein a dielectric loss of said piezoelectric ceramic composition is smaller than a dielectric loss of a piezoelectric ceramic composition of the above general formula not containing said added elements.

54. A piezoelectric ceramic composition as set forth in claim 47, wherein a Curie temperature T_c of said piezoelectric ceramic composition is larger than a Curie temperature of a piezoelectric ceramic composition of the above general formula not containing said added elements.

55. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has a piezoelectric d_{31} constant of not less than 30 pm/V.

56. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has an electromechanical coupling coefficient K_p of not less than 0.3.

57. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has a piezoelectric g_{31} constant of not less than 7×10^{-3} Vm/N.

58. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has a mechanical quality factor Q_m of not less than 50.

59. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has a relative dielectric constant of not less than 400.

60. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has a dielectric loss of not more than 0.09.

61. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has a Curie temperature T_c of not less than 200°C .

62. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has a piezoelectric d_{31} constant of not less than 30 pm/V and a Curie temperature T_c of not less than 200°C .

63. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has a piezoelectric g_{31} constant of not less than 7×10^{-3} Vm/N and a Curie temperature T_c of not less than 200°C .

64. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has an electromechanical coupling coefficient K_p of not less than 0.3 and a Curie temperature T_c of not less than 200°C .

65. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has a mechanical quality factor Q_m of not

less than 50 and a Curie temperature T_c of not less than 200°C.

66. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has a dielectric loss of not more than 0.09 and a Curie temperature T_c of not less than 200°C.

67. A piezoelectric ceramic composition as set forth in claim 47, wherein said piezoelectric ceramic composition has a piezoelectric d_{31} constant of not less than 30 pm/V, an electromechanical coupling coefficient K_p of not less than 0.3, and a Curie temperature T_c of not less than 200°C.

68. A method of production of a piezoelectric ceramic composition comprising mixing and sintering a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z-w}Ta_zSb_w)O_3$, where x , y , z , and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ and an additive including at least one metal element selected from nickel, iron, magnesium, copper, and zinc.

69. A method of production of a piezoelectric ceramic composition comprising mixing a compound containing lithium, a compound containing sodium, a compound containing potassium, a compound containing niobium, a compound containing tantalum, and a compound containing antimony by a stoichiometric ratio giving, after sintering, a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z-w}Ta_zSb_w)O_3$, where x , y , z , and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ or a stoichiometric ratio considering substitution by a metal element contained in the following additive, mixing an additive containing at least one metal element selected from nickel, iron, magnesium, copper, and zinc, and sintering the result.

70. A method of production of a piezoelectric ceramic composition as set forth in claim 69, wherein said compound containing lithium is Li_2CO_3 , said compound

containing sodium is Na_2CO_3 , said compound containing potassium is K_2CO_3 , said compound containing niobium is Nb_2O_5 , said compound containing tantalum is Ta_2O_5 , and said compound containing antimony is Sb_2O_5 or Sb_2O_3 , and said additive is at least one additive selected from NiO , Fe_2O_3 , Mn_2O_5 , Cu_2O , MnO , CuO , and ZnO .

71. A piezoelectric element having a piezoelectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 47.

72. A piezoelectric element having a piezoelectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 68.

73. A dielectric element having a dielectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 47.

74. A dielectric element having a dielectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 68.

75. A piezoelectric ceramic composition having a compound of a general formula $\{\text{Li}_x(\text{K}_{1-y}\text{Na}_y)_{1-x}\}(\text{Nb}_{1-z}\text{Ta}_z\text{Sb}_w)\text{O}_3$ where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ as a main ingredient, wherein

said piezoelectric ceramic composition contains at least one metal element selected from silver, aluminum, gold, boron, barium, bismuth, calcium, cerium, cobalt, cesium, copper, dysprosium, erbium, europium, iron, gallium, gadolinium, germanium, hafnium, holmium, indium, iridium, lanthanum, lutetium, magnesium, manganese, neodymium, nickel, palladium, praseodymium, platinum, rubidium, rhenium, ruthenium, scandium, silicon, samarium, tin, strontium, terbium, titanium, thulium, vanadium, yttrium, ytterbium, zinc, and zirconium,

a total of the contents of said added elements is 0.0005 mol to 0.15 mol with respect to 1 mole of the compound of the above general formula, and

an open porosity is not more than 0.4 vol%.

76. A piezoelectric ceramic composition as set forth in claim 75, wherein an apparent density of said piezoelectric ceramic composition is larger than an apparent density of a piezoelectric ceramic composition of the above general formula not containing said added elements.

77. A piezoelectric ceramic composition as set forth in claim 75, wherein a porosity or open porosity of said piezoelectric ceramic composition is smaller than a porosity or open porosity of a piezoelectric ceramic composition of the above general formula not containing said added elements.

78. A method of production of a piezoelectric ceramic composition comprising mixing and sintering a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z-w}Ta_zSb_w)O_3$, where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ and an additive including at least one metal element selected from silver, aluminum, gold, boron, barium, bismuth, calcium, cerium, cobalt, cesium, copper, dysprosium, erbium, europium, iron, gallium, gadolinium, germanium, hafnium, holmium, indium, iridium, lanthanum, lutetium, magnesium, manganese, neodymium, nickel, palladium, praseodymium, platinum, rubidium, rhenium, ruthenium, scandium, silicon, samarium, tin, strontium, terbium, titanium, thulium, vanadium, yttrium, ytterbium, zinc, and zirconium.

79. A method of production of a piezoelectric ceramic composition comprising mixing a compound containing lithium, a compound containing sodium, a compound containing potassium, a compound containing niobium, a compound containing tantalum, and a compound containing antimony by a stoichiometric ratio giving, after sintering, a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z-w}Ta_zSb_w)O_3$, where x, y, z, and w are in the

ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ or a stoichiometric ratio considering substitution by a metal element contained in the following additive, mixing an additive containing at least one metal element selected from silver, aluminum, gold, boron, barium, bismuth, calcium, cerium, cobalt, cesium, copper, dysprosium, erbium, europium, iron, gallium, gadolinium, germanium, hafnium, holmium, indium, iridium, lanthanum, lutetium, magnesium, manganese, neodymium, nickel, palladium, praseodymium, platinum, rubidium, rhenium, ruthenium, scandium, silicon, samarium, tin, strontium, terbium, titanium, thulium, vanadium, yttrium, ytterbium, zinc, and zirconium, and sintering the result.

80. A method of production of a piezoelectric ceramic composition as set forth in claim 79, wherein said compound containing lithium is Li_2CO_3 , said compound containing sodium is Na_2CO_3 , said compound containing potassium is K_2CO_3 , said compound containing niobium is Nb_2O_5 , said compound containing tantalum is Ta_2O_5 , and said compound containing antimony is Sb_2O_5 or Sb_2O_3 and said additive is at least one additive selected from Ag_2O , Al_2O_3 , Au , Au_2O_3 , B_2O_3 , H_3BO_3 , BaO , BaO_2 , BaCO_3 , Bi_2O_3 , CaO , CaCO_3 , CeO_2 , $\text{Ce}_2(\text{CO}_3)_3$, CoO , Co_3O_4 , CoCO_3 , Cs_2CO_3 , CuO , Cu_2O , Dy_2O_3 , Er_2O_3 , Eu_2O_3 , Fe_2O_3 , Ga_2O_3 , Gd_2O_3 , GeO_2 , HfO_2 , Ho_2O_3 , In_2O_3 , IrO_2 , Ir_2O_3 , La_2O_3 , Lu_2O_3 , MgO , MgC_2O_4 , MnO , MnO_2 , Mn_2O_3 , Mn_3O_4 , Nd_2O_3 , Nd_2CO_3 , NiO , NiCO_3 , PdO , Pr_2O_3 , Pr_6O_{11} , $\text{Pr}_2(\text{CO}_3)_3$, PtO_2 , Rb_2O , Rb_2CO_3 , Re_2O_7 , RuO_2 , Sc_2O_3 , SiO_2 , SiO , SiC , Sm_2O_3 , SnO , SnO_2 , SrO , SrCO_3 , Tb_4O_7 , TiO , Ti_2O_3 , TiO_2 , Tm_2O_3 , V_2O_3 , V_2O_4 , V_2O_5 , Y_2O_3 , $\text{Y}_2(\text{CO}_3)_3$, Yb_2O_3 , ZrO , and ZrO_2 .

81. A piezoelectric element having a piezoelectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 75.

82. A piezoelectric element having a piezoelectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 78.

83. A dielectric element having a dielectric body

comprised of a piezoelectric ceramic composition produced by a method of production of claim 75.

84. A dielectric element having a dielectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 78.

85. A piezoelectric ceramic composition having a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z-w}Ta_zSb_w)O_3$, where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ as a main ingredient, wherein

said piezoelectric ceramic composition contains at least one metal element selected from magnesium, calcium, strontium, and barium as an added element, and

a total of the contents of said added elements is 0.0001 mol to 0.10 mol with respect to 1 mole of the compound of the above general formula.

86. A piezoelectric ceramic composition as set forth in claim 85, wherein said added elements are included substituting at least part of the lithium, potassium, and sodium of said compound of said general formula.

87. A piezoelectric ceramic composition having a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z-w}Ta_zSb_w)O_3$, where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ as a main ingredient, wherein

said piezoelectric ceramic composition contains at least one metal element selected from silicon, indium, and scandium as an added element, and

a total of the contents of said added elements is not more than 0.08 mol with respect to 1 mole of the compound of the above general formula.

88. A piezoelectric ceramic composition as set forth in claim 87, wherein a total of the contents of said added elements is 0.0001 mol to 0.08 mol with

respect to 1 mole of the compound of the above general formula.

89. A piezoelectric ceramic composition having a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z}Ta_zSb_w)O_3$, where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ as a main ingredient, wherein

said piezoelectric ceramic composition contains bismuth as an added element, and

a content of said added element is 0.0001 mol to 0.004 mol with respect to 1 mole of the compound of the above general formula.

90. A piezoelectric ceramic composition as set forth in claim 85, wherein a piezoelectric d_{31} constant of said piezoelectric ceramic composition is larger than a piezoelectric d_{31} constant of a piezoelectric ceramic composition of the above general formula not containing said added elements.

91. A piezoelectric ceramic composition as set forth in claim 85, wherein an electromechanical coupling coefficient K_p of said piezoelectric ceramic composition is larger than an electromechanical coupling coefficient K_p of a piezoelectric ceramic composition of the above general formula not containing said added elements.

92. A piezoelectric ceramic composition as set forth in claim 85, wherein a piezoelectric g_{31} constant of said piezoelectric ceramic composition is larger than a piezoelectric g_{31} constant of a piezoelectric ceramic composition of the above general formula not containing said added elements.

93. A piezoelectric ceramic composition as set forth in claim 85, wherein a mechanical quality factor Q_m of said piezoelectric ceramic composition is larger than a mechanical quality factor Q_m of a piezoelectric ceramic composition of the above general formula not containing said added elements.

94. A piezoelectric ceramic composition as set

forth in claim 85, wherein a relative dielectric constant of said piezoelectric ceramic composition is larger than a relative dielectric constant of a piezoelectric ceramic composition of the above general formula not containing said added elements.

95. A piezoelectric ceramic composition as set forth in claim 85, wherein a dielectric loss of said piezoelectric ceramic composition is smaller than a dielectric loss of a piezoelectric ceramic composition of the above general formula not containing said added elements.

96. A piezoelectric ceramic composition as set forth in claim 85, wherein a Curie temperature T_c of said piezoelectric ceramic composition is larger than a Curie temperature of a piezoelectric ceramic composition of the above general formula not containing said added elements.

97. A piezoelectric ceramic composition as set forth in claim 85, wherein said piezoelectric ceramic composition has a piezoelectric d_{31} constant of not less than 30 pm/V.

98. A piezoelectric ceramic composition as set forth in claim 85, wherein said piezoelectric ceramic composition has an electromechanical coupling coefficient K_p of not less than 0.3.

99. A piezoelectric ceramic composition as set forth in claim 85, wherein said piezoelectric ceramic composition has a piezoelectric g_{31} constant of not less than 7×10^{-3} Vm/N.

100. A piezoelectric ceramic composition as set forth in claim 85, wherein said piezoelectric ceramic composition has a mechanical quality factor Q_m of not less than 50.

101. A piezoelectric ceramic composition as set forth in claim 85, wherein said piezoelectric ceramic composition has a relative dielectric constant of not less than 400.

102. A piezoelectric ceramic composition as set

forth in claim 85, wherein said piezoelectric ceramic composition has a dielectric loss of not more than 0.09.

103. A piezoelectric ceramic composition as set forth in claim 85, wherein said piezoelectric ceramic composition has a Curie temperature T_c of not less than 200°C.

104. A piezoelectric ceramic composition as set forth in claim 85, wherein said piezoelectric ceramic composition has a piezoelectric d_{31} constant of not less than 30 pm/V and a Curie temperature T_c of not less than 200°C.

105. A piezoelectric ceramic composition as set forth in claim 85, wherein said piezoelectric ceramic composition has a piezoelectric g_{31} constant of not less than 7×10^{-3} Vm/N and a Curie temperature T_c of not less than 200°C.

106. A piezoelectric ceramic composition as set forth in claim 85, wherein said piezoelectric ceramic composition has an electromechanical coupling coefficient K_p of not less than 0.3 and a Curie temperature T_c of not less than 200°C.

107. A piezoelectric ceramic composition as set forth in claim 85, wherein said piezoelectric ceramic composition has a mechanical quality factor Q_m of not less than 50 and a Curie temperature T_c of not less than 200°C.

108. A piezoelectric ceramic composition as set forth in claim 85, wherein said piezoelectric ceramic composition has a dielectric loss of not more than 0.09 and a Curie temperature T_c of not less than 200°C.

109. A piezoelectric ceramic composition as set forth in claim 85, wherein said piezoelectric ceramic composition has a piezoelectric d_{31} constant of not less than 30 pm/V, an electromechanical coupling coefficient K_p of not less than 0.3, and a Curie temperature T_c of not less than 200°C.

110. A method of production of a piezoelectric

ceramic composition comprising mixing and sintering a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z-w}Ta_zSb_w)O_3$, where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ and an additive including at least one metal element selected from magnesium, calcium, strontium, and barium.

111. A method of production of a piezoelectric ceramic composition comprising mixing and sintering a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z-w}Ta_zSb_w)O_3$, where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ and an additive including at least one metal element selected from silicon, indium, and scandium.

112. A method of production of a piezoelectric ceramic composition comprising mixing and sintering a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z-w}Ta_zSb_w)O_3$, where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ and an additive including bismuth.

113. A method of production of a piezoelectric ceramic composition comprising preparing a compound containing lithium, a compound containing sodium, a compound containing potassium, a compound containing niobium, a compound containing tantalum, and a compound containing antimony by a stoichiometric ratio giving, after sintering, a compound of a general formula $\{Li_x(K_{1-y}Na_y)_{1-x}\}(Nb_{1-z-w}Ta_zSb_w)O_3$, where x, y, z, and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ or a stoichiometric ratio considering substitution by a metal element contained in the following additive, mixing an additive containing at least one metal element selected from magnesium, calcium, strontium, and barium, and sintering the result.

114. A method of production of a piezoelectric ceramic composition as set forth in claim 113, wherein said compound containing lithium is Li_2CO_3 , said compound

containing sodium is Na_2CO_3 , said compound containing potassium is K_2CO_3 , said compound containing niobium is Nb_2O_5 , said compound containing tantalum is Ta_2O_5 , and said compound containing antimony is Sb_2O_3 or Sb_2O_5 , and said additive is at least one additive selected from MgO , MgC_3 , CaO , CaCO_3 , SrO , SrCO_3 , BaO , and BaCO_3 .

115. A method of production of a piezoelectric ceramic composition comprising preparing a compound containing lithium, a compound containing sodium, a compound containing potassium, a compound containing niobium, a compound containing tantalum, and a compound containing antimony by a stoichiometric ratio giving, after sintering, a compound of a general formula $\{\text{Li}_x(\text{K}_{1-y}\text{Na}_y)_{1-x}\}(\text{Nb}_{1-z-w}\text{Ta}_z\text{Sb}_w)\text{O}_3$ where x , y , z , and w are in the ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ or a stoichiometric ratio considering substitution by a metal element contained in the following additive, mixing an additive containing at least one metal element selected from strontium, indium, and scandium, and sintering the result.

116. A method of production of a piezoelectric ceramic composition as set forth in claim 115, wherein said compound containing lithium is Li_2CO_3 , said compound containing sodium is Na_2CO_3 , said compound containing potassium is K_2CO_3 , said compound containing niobium is Nb_2O_5 , said compound containing tantalum is Ta_2O_5 , and said compound containing antimony is Sb_2O_3 or Sb_2O_5 , and said additive is at least one additive selected from SiO_2 , In_2O_3 , and Sc_2O_3 .

117. A method of production of a piezoelectric ceramic composition comprising preparing a compound containing lithium, a compound containing sodium, a compound containing potassium, a compound containing niobium, a compound containing tantalum, and a compound containing antimony by a stoichiometric ratio giving, after sintering, a compound of a general formula $\{\text{Li}_x(\text{K}_{1-y}\text{Na}_y)_{1-x}\}(\text{Nb}_{1-z-w}\text{Ta}_z\text{Sb}_w)\text{O}_3$ where x , y , z , and w are in the

ranges of $0 \leq x \leq 0.2$, $0 \leq y \leq 1$, $0 < z \leq 0.4$, and $0 < w \leq 0.2$ or a stoichiometric ratio considering substitution by bismuth atoms contained in the following additive, mixing an additive containing bismuth, and sintering the result.

118. A method of production of a piezoelectric ceramic composition as set forth in claim 117, wherein said compound containing lithium is Li_2CO_3 , said compound containing sodium is Na_2CO_3 , said compound containing potassium is K_2CO_3 , said compound containing niobium is Nb_2O_5 , said compound containing tantalum is Ta_2O_5 , and said compound containing antimony is Sb_2O_3 or Sb_2O_5 and said additive is Bi_2O_3 .

119. A piezoelectric element having a piezoelectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 85.

120. A piezoelectric element having a piezoelectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 110.

121. A dielectric element having a dielectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 85.

122. A dielectric element having a dielectric body comprised of a piezoelectric ceramic composition produced by a method of production of claim 110.